PRE-INSTALLATION TESTING OF A HIGH INTEGRITY CONTAINER (HIC) FILLING AND HANDLING SYSTEM

C. Caprara
G. J. Beck
Philadelphia Electric Company

L. B. Hirst, Jr.
M. A. Fachada
Stone & Webster Engineering Corporation

INTRODUCTION

Peach Bottom Atomic Power Station, a twin-unit (1,065 MW each) boiling water reactor (BWR) plant, started commercial operation in 1974. The units' common radwaste system is typical of the systems designed in the late 1960s, processing approximately 24,000 cubic feet of dewatered resin waste each year.

While hardware and procedural changes are being implemented in radwaste operations to improve the efficiency of contaminated water treatment systems and to reduce overall waste volumes, the processing and packaging of spent resin wastes will continue to be a major task.

In September 1982, in response to burial site requirements, Philadelphia Electric Company (PECo) began using high integrity containers (HICs) for the packaging of dewatered radioactive filter sludges and resins. The replacement of the previously used open-top, 55-gallon steel drum with the new 55-gallon polyethylene HIC and its 8-inch top-centered fill port created several operational problems and aggravated some long-standing packaging system operational difficulties. While the problems did not prevent the continued use of HICs, it became clear that modifications would be necessary to ensure reliable radwaste packaging and handling.

PROBLEM DESCRIPTION

HICs are placed manually on an empty-drum conveyor and transported to a transfer cart. The cart then takes the HICs to the fill, capping, and decontamination stations, and finally to one of three storage conveyors to await offsite shipment. At the fill station, the HIC is filled with dewatered spent resin discharged from a centrifuge through a storage hopper and fill pipe system.

The larger openings in the previously used carbon steel drums enabled filling without accurate cart positioning or sophisticated fill level control. The drum resin level was monitored by an operator using a closed-circuit television system, with a wall-mounted camera in the fill area.

Since the 8-inch-diameter opening in the HIC prevents direct observation of the resin level, the translucent sidewall is illuminated by back-lighting, thereby enabling the level of material within the HIC to be observed by its shadow on the HIC sidewall. However, because the resin consistency tends to vary, causing different height mounds, the sidewall indication of level is difficult to interpret by the fill station operator.

This poor indication of resin level, combined with difficulty in positioning the HIC's 8-inch opening under the fill pipe, caused frequent spilling of the resin on the container top. At the capping station, the spilled resin had to be removed so that a HIC closure lid could be effectively installed. Since contaminated resin was spilled, decontamination of each HIC was necessary. The surrounding area was also frequently washed down to minimize accumulated surface contamination.

The combination of resin mounding in the container and poor level indication caused operators to underfill the HICs in an effort to prevent resin spillage, contributing to poor fill efficiency.

Another problem associated with the change from steel drums to the polyethylene HICs was the movement of HICs on the storage conveyors. Their soft bottoms and comparatively large contact area prevented their traveling by gravity down the sloped roller conveyors, as was possible with the steel drums.

The problems encountered by the introduction of the HIC further compounded basic difficulties in the original system operation. Slight variations in centrifuge feed system performance result in significant variations in the characteristics of the centrifuged product. While well within the allowable free-water requirement, the centrifuged resin material may range from an easy-to-handle, almost granular material to a clumpy, sticky material that is extremely difficult to handle. The initial design of the hopper and fill pipe did not provide enough flexibility for this wide variation in the material's flowability.

PROBLEM RESOLUTION

Initial efforts were directed at improvements that could be easily implemented and would enhance continued use of the HICs. These improvements, which did not change the basic system or eliminate its inherent problems, utilized operator experience to meet the basic objective of sustaining operations. However, much more had to be done to develop a satisfactory long-term solution to the filling and handling problems.

PECo, in conjunction with Stone & Webster Engineering Corporation, performed extensive studies to establish a modification concept that would correct the problems. The conceptual design addressed the transfer of centrifuge-dewatered waste from the centrifuge to its ultimate placement in an HIC, the accurate positioning of HICs during filling and storage, improved fill efficiency, reliability and maintainability of components, and installation that would not interrupt normal plant operations.

From a survey conducted of systems handling similar type materials, it was learned that the initially installed Peach Bottom system was in fact state of the art for radioactive resin handling. Proven alternatives were simply not available. The most important conclusion reached during the survey was that the experienced materials handling equipment suppliers will not release a system without full-scale shop testing of the exact product to be handled.

The following key decisions influenced the course of the project:

1. Due to cost and schedule restraints, as many as possible of the existing system components would be retained.

2. Preliminary full-scale testing of key design concepts would be performed prior to finalizing the total system design.

3. Final shop testing of the assembled system prior to installation would be required.

4. A programmable controller would be employed to facilitate control logic changes during testing.

5. All reasonable efforts would be made to obtain improved packaging efficiency (volume reduction).

6. If possible, resin would not be stored in the hopper, but conveyed directly to an HIC immediately after centrifuging.

TESTING

Proper development of the system modifications required extensive preliminary full-scale shop testing and final in-shop system testing.

The preliminary full-scale shop testing, which confirmed the basic conceptual design, also provided information regarding material flow characteristics and potential design problems. Some of the changes to the conceptual design that occurred as a result of this testing included:

1. Increase of the vibrating frequency of the dewatered resin hopper vibrators to twice that originally supplied by the hopper manufacturer. The optimum frequency was found to be well above that recommended by suppliers prior to testing.

2. Deletion of the fill-pipe air cannon originally intended to provide storage hopper bridge breaking at the hopper discharge connection.

3. Modification of the fill control sequence to suit actual resin characteristics.

4. Improvement of the indexing fill-head funnel geometry.

Final testing of the assembled system prior to shipment allowed identification of several interferences and the prove-out of the system controls. A demonstration was conducted for construction and operations personnel.

SYSTEM MODIFICATIONS

The overall system modifications that were performed are as follows:

1. Improvement of transfer cart positioning with the use of proximity limit switches.

2. Elimination of resin spilling with continuous resin-level sensing combined with direct "full" indication and an indexing direct-connection HIC fill-head.

3. Improvement of vibration of the storage hopper and addition of vibration on the fill pipe.

4. Use of a single-knife gate valve at the hopper outlet.

5. Correction of storage conveyor problems by the addition of overhead pushers.

6. Integration of control logic for all of the preceding items, using a programmable controller.

7. Improvement of filling efficiency by HIC vibration during filling.

CONCLUSIONS

The modification design effort yielded valuable information regarding dewatered resin handling. The project also demonstrated the benefits derived from employing a well-defined test program when the use of concepts, processes, or components not designed for the intended application are involved. The results prove that with proper planning, testing can be a valuable design tool and need not evolve into a "research project."

Specifically, the basic objective of efficient and reliable HIC filling has been achieved. The testing provided hands-on information of which concepts will and will not work, thus facilitating the resolution of suggested field changes.

Improved packaging efficiency was investigated, and there is now reliable data on the capability of vibration to achieve the volume reduction of centrifuge-dewatered resin. To the extent practical, improved packaging efficiency has been realized at the Peach Bottom station.

Concurrently with the effort for the Peach Bottom station, a similar effort was conducted for PECo's Limerick generating station, a twin-unit BWR presently under construction. The original solid radwaste system design for Limerick was based on the use of large disposable liners. An evaluation of the Limerick design was made based on the data obtained during the Peach Bottom testing, and extensive changes were found to be necessary. As with Peach Bottom, testing of the assembled system prior to shipment was a requirement. The Limerick system, which utilizes large HICs, also effects significant volume reduction through the use of HIC vibration.